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FLOODING AND STORMWATER IMPACT ASSESSMENT FOR PROPOSED REZONING

40 RAYFORD STREET AND 19 DAYDAWN AVENUE WARNERS BAY

Project: 16/155
JANUARY 2017

PREPARED FOR:

Warners Bay Holdings Pty Ltd

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Report Title:	Flooding and Stormwater Impact Assessment
Project:	40 Rayford Street, Warners Bay
Reference:	16/155
Client:	Warners Bay Holdings Pty Ltd
Prepared For:	Lake Macquarie City Council
DA/CC Reference:	
Document Number:	127461
Draft/Final:	For Planning Proposal

Document Register

Issue	Details of Change	Prepared	Reviewed	Date
A	Initial Issue for Discussion	BC		
B	Inclusion of Daydawn Avenue and 18 Winterlake Road	DE		3/08/017

EXECUTIVE SUMMARY

This flooding and stormwater impact assessment has been prepared to support a proposed rezoning at 40 Rayford Street, 19 Daydawn Avenue and 18 Winterlake Road, Warners Bay. Site flooding and stormwater management, including water quality control and stormwater detention, are considered in the assessment and will be included as a supporting document for the proposed rezoning of the site.

The only identified watercourse across the subject land is located on 18 Winterlake Road in the northern portion of the site. The catchment to this water course is small and the flows have been considered as part of this assessment. There is no known source of external flooding onto the subject land apart from runoff generated from the site catchment. An assessment of the flows from the catchment to each of the identified outlets is included for storm events up to and including the 1 in 100 year Average Recurrence Interval (ARI) storm.

The proposal utilises conventional pit and pipe conveyance to the site outlets and on-site stormwater quality/quantity control in a basin proposed in the location of the existing farm dam. A MUSIC model was prepared to simulate the performance and treatment train effectiveness of the adopted system with respect to LMCC's treatment targets. The results summarised below show that water quality is satisfactorily treated to LMCC's Stormwater Treatment Targets.

	% Reduction	Objective Met
Total Suspended Solids (<5mm)	91	Y
Total Phosphorus	72	Y
Total Nitrogen	45	Y
Gross Pollutants	100	Y

The existing downstream drainage system is known to be at or exceeding capacity in larger storm events. The results of this assessment show that the impacts of development of the land and construction of the water quality control basin will reduce the load on the downstream system consequently reducing the number of overflows from the existing system.

The following table identifies the pre and post development overflow of the drainage system in the vicinity of overland flow pathway between the properties at 5 and 7 Peachwood Close Warners Bay.

Storm Event	Pre-developed Overflow m^3/s	Post Developed Overflow m^3/s	Reduction in Bypass Flows m^3/s
1 Year ARI (100% AEP)	2.132	1.798	**0.334**
5 Year ARI (20% AEP)	5.234	4.628	**0.606**
10 Year ARI (10% AEP)	7.156	6.445	**0.711**
100 Year ARI (1%AEP)	10.642	8.355	**2.287**

This results of this assessment demonstrate that the stormwater system proposed for the subject land will reduce the flooding impacts currently experienced by downstream properties.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF PHOTOGRAPHS

1.0 INTRODUCTION

This flooding and stormwater impact assessment has been prepared on behalf of Warners Bay Holdings Pty Ltd to support a planning proposal at 40 Rayford Street 19 Daydawn Avenue and 18 Winterlake Road, Warners Bay.

The aim of this assessment is to determine the impacts of urban development of the land in terms of storm water quality and flooding. This study is limited to the discussion of storm water impacts associated with the rezoning and will need additional detailed design once the rezoning is approved in the form of a Water Cycle Management plan. This study considers a scheme of stormwater controls as a means of managing water quantity and therefore the downstream flood risks.

For the purposes of this study, investigation was limited to topographic assessment of LIDAR contours and aerial imagery only. A site walk-over confirmed the position and direction of stormwater inlets and outlets, however it is expected that any future application for subdivision on the subject land would require a more detailed assessment of these outlets as part of a detailed design plan.

1.1 EXISTING SITE DESCRIPTION

The subject land is described by Lot 6 DP 814499 at 40 Rayford Street, Lot 100 DP 1173625 at 19 Daydawn Avenue and Lot 350 DP 776503 at 18 Winterlake Road, Warners Bay. The subject land is bounded by Munibung Hill in the west and existing residential development in the east. Existing use of the subject land is limited to rural activities.

The subject land is accessed by Winterlake Street in the north and Rayford Street and Daydawn Avenue in the south. Rayford Street and Daydawn Avenue have been constructed with a T-shaped turning head, with one ‘leg’ of the intersection facing to the north. It is likely that the future development of the subject land will connect between Rayford Street and Winterlake Street. Winterlake Street has been constructed as an 11m wide carriageway with kerb and gutter and a concrete footpath located immediately beside the kerb on each side.

1.1 SITE TOPOGRAPHY

Topographic features of the subject land are described by four distinct areas: The western most area is the east-facing escarpment of Munibung Hill. This upper western area is regarded as being very steep, at times up to 1V:1H or 45° inclination with densely vegetated surfaces in an elevation range from RL70-115m AHD.

The next area is the upper middle area, described as moderately sloping up to 15% and in an elevation range from RL 60-76m AHD. This portion of the site is mostly cleared and currently used for livestock grazing. The third area of the site between the upper middle area and the lower slopes is steep, ranging up to 30% (17° inclination). This portion of the site has a varying degree of vegetation, from fully cleared to densely vegetated, particularly within the southern half of the site. The third area ranges in elevation from RL 35-RL70m AHD.

Figure 1 Site Locality Plan

The lower slopes are the area subject to the planning proposal. Slopes in this area range from 5-10%, and in elevation from RL26-35m AHD. This area contains a number of low flat gullies that drains runoff from the upper three areas toward the eastern boundary outlet points. Lower slopes are intersected by a series of fences for the containment of horses kept on the property.

Figure 2 Existing Site Features

1.2 PLANNING GUIDELINES

1.2.1 EAST MUNIBUNG HILL PRECINCT PLAN

Development controls exhibited in the East Munibung Hill Precinct Plan[1] indicates limited development potential above RL54m AHD. Slope stability constraints identified in the Geotechnical assessment[2] suggest development potential above the lower slopes is limited, and any such development may require remedial works, such as surface and sub-surface drainage paths and soil stabilisation measures prior to development. The lower slopes are investigated as part of the rezoning application.

1.2.2 LAKE MACQUARIE CITY COUNCIL DCP

Lake Macquarie City Council (LMCC) identifies sustainable water cycle management as an essential planning criterion for development; to minimise the negative impacts of increased urban activity on the City's waterways and lake. All development within the Lake Macquarie's local government area must provide for sustainable water cycle management, in accordance with LMCC's Development Control Plan[3]

[1] Lake Macquarie Development Control Plan 2014 – Revision 12, Part 12 – Precinct Area Plans – East Munibung Hill, December 2016
[2] Regional Geotechnical Solutions – Slope Stability Assessment RGS01 426.1-AB, 6 December 2016
[3] Lake Macquarie Development Control Plan 2014 – Revision 12, Part 8 – Subdivision Development, December 2016

2.0 FLOODING ASSESSMENT

2.1 SITE HYDROLOGICAL CONTEXT

In the context of the overall catchment, the subject land is positioned on the south east facing slopes of Munibung Hill. The Munibung Hill escarpment contains dense native vegetation with a thick canopy and ground cover. The remainder of the subject land has been mostly cleared, now with a thick grass cover, except on the lower slopes where the grasses are kept generally shorter on account of grazing horses.

The use of infiltration techniques for cleaning stormwater and promoting sub-surface flows is limited within the lower slopes due to the higher presence of fine-grained soils. Vegetation throughout the site will be retained where possible.

2.2 STORMWATER OUTLETS

There are four apparent outlets for stormwater runoff from the subject land. These are labelled as Outlets A-D on Figure 3 and as shown in Photographs 1-3.

Outlet A is a formal overland flow path between Lots 8 and 9 DP 244868 at 5 and 7 Peachwood Close. This formal flowpath contains a 675mm diameter concrete stormwater pipe connecting with the stormwater pit and pipe system in Peachwood Close. A grassed channel aligned along the boundary of the subject land, intercepts surface flows from a greater area and channels this toward Outlet A.

Photograph 1: Outlet A, looking from the subject land toward Peachwood Close

Outlet B is a small diameter pipe draining through an easement over Lot 8 DP249244, 12 Rayford Street. This pipe is not recorded on Council's stormwater records and is therefore assumed to connect to the existing stormwater pit at the front of number 10 Rayford Street. At the time of field investigation, this drain was described as frequently overtopping and causing inundation of the rear surrounds of this affected property. It is

noted that the flooding of this drain coincided with overflows of the farm dam located approximately 50m upslope of the property.

Outlet C is the turning head at the end of Rayford Close. The remaining portion of the site drains toward a steep gully in the south, which tends toward the southeast corner. The details of this outlet (Outlet D) were not recorded as part of this study.

Photograph 2: Outlet B, looking to the south.

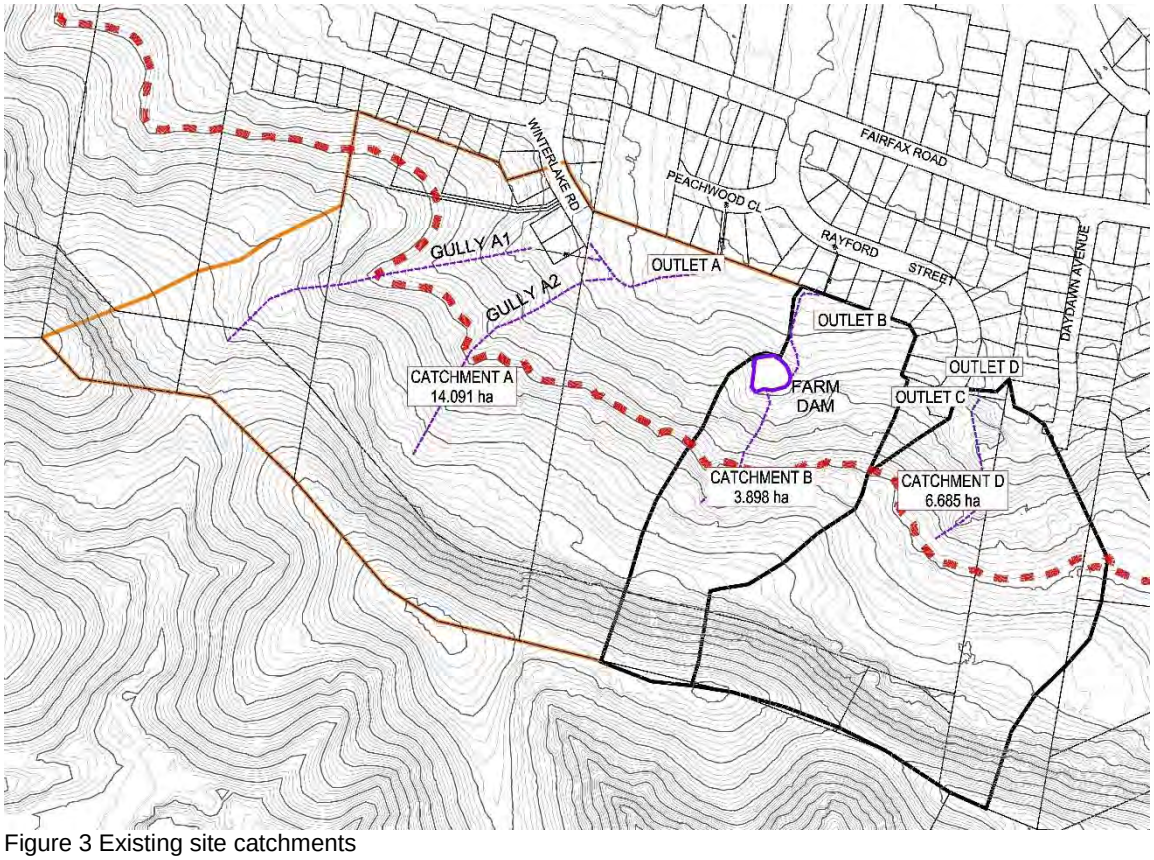

Figure 3 Existing site catchments

2.3 STORMWATER CATCHMENTS

Features of the topography, including farm dams and gullies, concentrate stormwater runoff shown by the catchment boundaries on **Figure 3**. Catchment A, which extends well beyond the northern limits of the subject land, has been further delineated into the individual sub-catchments draining through Gullies marked A1 and A2. A headwall outlet visible at the end of Winterlake Street is assumed to be directing flows from Gully A1 around or underneath number 20 Winterlake Street. Outflows from this headwall currently discharge across the northern boundary of the subject land and dissipate across the natural landform toward Outlet A. There are no apparent stormwater pits at the end of Winterlake Street collecting surface flows from the end of the pavement. Outlet D extends beyond the limits of the southern boundary.

2.4 FLOODING

The subject land lies within the regional catchment draining ultimately through North Creek at Warners Bay. The land is not identified on the LEP[4] as flood-prone. All storm flows leading to Outlets A-D is caused by runoff from the catchments identified on Figure 3.

HYDROLOGICAL/HYDRAULIC MODEL

A computer model was established with the 12d Model software using event-based simulation of storm events to determine the runoff quantities.

Rainfall at each node was simulated from temporal patterns for storm events ranging from 20 minutes through to 720minutes in the design storms in accordance with Australian Rainfall and Runoff[5]. The average rate of rainfall was provided by the standard Intensity Frequency Duration tables for the Warners Bay area.

[4] Lake Macquarie City Council Local Environmental Plan (LEP) 2014

[5] Institution of Engineers, Australia 1987, Australian Rainfall and Runoff (AR&R) – A guide to Flood estimation

The pre-developed site was modelled with an impervious fraction of zero. Development within the lower slopes, identified as part of the proposed rezoning has an adopted fraction of 60%.

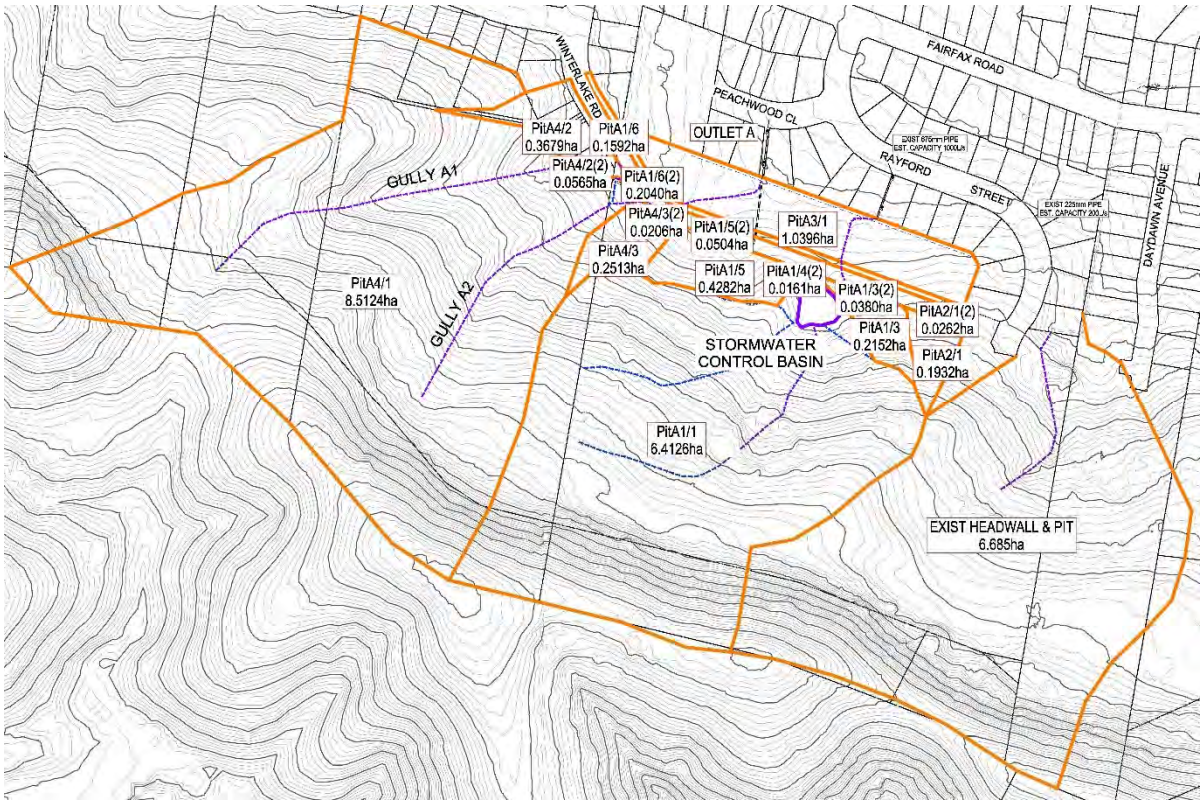

Figure 4: Proposed Developed Catchments

Horton infiltration (ILSAX) was utilised with final infiltration rates of 25mm/hr and relatively wet conditions prior to the start of the storm. Time of concentration for each of the model nodes was based on the Kinematic Wave equations adopted in AR&R. The surface roughness coefficients adopted was n=0.4 for rural surfaces. The results of such analysis generally gave minimum times of 5 minutes for directly connected impervious surfaces such as roads and roofs, and pervious area times dependent on flow path length, slope and roughness.

2.1 ESTIMATED PEAK FLOWS

The estimated peak flows from the computer model are outlined in Table 2.1. For the purposes of the drainage analysis all flows are considered through Outlet A as the size and location of the pipe from Outlet B cannot be confirmed at this time. At the time of preparing a detailed design for the subject land the location and capacity of the pipe from Outlet B will be confirmed.

Table 2.1 Catchment Outflow Summary

	1 YR (L/s)	5 YR (L/s)	10 YR (L/s)	100 YR (L/s)
Outlet A	3422	6578	8501	12032

The existing pipe draining to Peachwood Close at Outlet A is undersized for the contributing upstream catchment. From the calculated discharge rates it is expected that the excess flow is conveyed along the grassed channel to Peachwood Close.

Lake Macquarie Council provided information from their GIS system regarding the downstream stormwater system which was included in the drainage model. Pipe sizes and types were supplied with the information from

Lake Macquarie City Council and the pipe grades were assumed to run parallel with the existing surface. The following images shown the location of the downstream system.

2.2 STORMWATER DETENTION

A stormwater detention basin with a storage volume of 2800m^3 has been modelled in the location of the existing farm dam. The modelled results from a staged outlet on the basin indicate that discharge rates from the developed site will reduce the load on the downstream system by retarding the flows for all storm events. While the existing drainage system through the nearby streets is known to be at capacity the consequence of retarding the flows from the subject land will act to reduce the number of overflows from the existing system.

The detention basin modelled for this assessment has been sized to fit the landform in the vicinity of the existing farm dam. The basin will be located on the upstream side of the connecting road between Winterlake Road and Daydawn Street to reduce any risk to downstream properties due to failure.

Rainwater tanks provided for each lot will have the effect of reducing mains water usage as well as reducing the peak of runoff for storms of smaller intensity. The same tanks tend to fill quickly in storms of higher intensity and have very little benefit in total storage for the more extreme weather events. Rainwater tanks were not modelled as part of this investigation.

3.0 STORMWATER MANAGEMENT STRATEGY

3.1 DESIGN PRINCIPLES

Proposed development of the subject land is limited to the creation of lots that have a street frontage. Future subdivision development of the subject land will place the extension of Winterlake Street aligned with the end of the turning head in Rayford Street, affording approximately 40m deep lots on the eastern side with smaller length properties on the western side. The orientation and alignment of lots will be dictated by the road layout.

The natural landform upslope of the proposed development will generally remain undisturbed. This is to reduce the likelihood of further vegetation loss and soil retention. Street trees will be designed to both sides of the proposed road extension in accordance with council's landscape design principles.

There are no known trunk drainage lines through the subject land, or leading directly from the subject land as the land is located at the extremity of the catchment(s). Drainage across the site is only attributed to direct runoff from the site. Most of the runoff from the catchment is sourced from the considerably larger areas upslope of the proposed rezoning areas. Runoff from the undeveloped upslope areas will need to be channelised to the farm dam through a series of cross-slope earth mounds and sub-surface drainage lines. This system of surface and sub-surface cut-off drains has also been identified in the Geotechnical report as a control measure for some of the risks associated with slope stability. The existing farm dam embankment will need to be re-built under geotechnical design and supervision, to ensure embankment stability. This farm dam (stormwater control dam) should be constructed as a dry detention basin to a depth that is sufficient to ensure outflows are piped safely to the outlet.

Concentrated flows approaching the site, such as from the headwall outlet near Winterlake Street and the farm dam outlet, will be directed along the Winterlake Street extension to a sag point located approximately adjacent to the pathway extension from Peachwood Close. The stormwater pipe will interconnect with the existing pipe in this pathway.

3.2 STORMWATER MANAGEMENT CONTROLS

A concept stormwater plan has been prepared detailing the proposed controls that will reduce the negative impacts to the physical environment on completion. The concept stormwater management plan, included in Figure 5, shows a combination of stormwater controls to mitigate the effects of flooding, and treatment of nutrients to ensure the stormwater leaving the subject land satisfies the development objectives. Further discussion to the effectiveness of these controls is included in the following sections of this strategy.

Figure 5 Concept Stormwater Management Plan

Overflows from the rainwater tanks will discharge to a common infiltration and inter-allotment drainage trench, which will serve a two-fold outcome of detention control and water quality control. The infiltration trench will have a subsoil drain installed to allow a low-flow outlet to the stormwater system.

Source Controls

On-site rainwater tanks are implicitly part of the proposal, implemented as part of dwelling approvals in accordance with the NSW state government Building Sustainability Index[6] requirements. Typically rainwater tanks are connected to each dwelling to supply rain water for internal re-use such as the laundry, toilet and external irrigation supply. This approach reduces potable water demand, and a partial reduction in storm water flows from each lot.

Conveyance Controls

Runoff from the lots upslope of the road will drain directly to the street kerb and gutter before being captured in street pits. Stormwater will be piped to the site outlets.

Discharge Controls

No additional discharge controls are intended as part of the redevelopment of the subject land. The existing network of stormwater pits and pipes in Peachwood Close, Rayford Close and Fairfax Road tail-out to a depression adjacent to a sports field south of Warners Bay Private Hospital.

[6] State Environmental Planning Policy – Building Sustainability Index, 2004

3.3 STORM WATER QUALITY

Frequent, low-intensity rainfall events tend to mobilise harmful pollutants such as suspended solids, nutrients and litter into the stormwater streams. Water quality modelling was performed in the Model for Urban Stormwater Improvement Conceptualisation (MUSIC) program, which uses temporal (time variable) rainfall data to simulate stormwater runoff and pollutant concentrations through a continuous time series.

MUSIC simulated results can be provided in the form of treatment train effectiveness, and directly compared with LMCC's water quality standards[7], as listed in Table 3.4.

3.3.1 RAINFALL AND EVAPORATION

The MUSIC model utilised the in-built rainfall information for the Northern Lake Macquarie Catchment as part of Lake Macquarie Council's MUSIC-LINK setup, obtained January 2017. Meteorological template includes 6 minute rainfall records over a ten year period from 1999 to 2008 and monthly evapotranspiration values over the same ten year period.

3.3.2 SOURCE NODES

Only the developable area of the lower slopes on the eastern side of the proposed street was included in the MUSIC model. All upstream runoff is intended to be collected and piped to the site outlets separately to the storm water quality control system proposed. The Source node was modelled using the default MUSIC Urban 'Residential' Node with rainfall/runoff parameters and pollutant load parameters consistent with the MUSIC-LINK defaults.

Table 3.1 Source Node Parameters

Parameter	Residential Surface
Catchment Area	1.04ha
Impervious Percentage	60%
Rainfall Threshold	1mm
Soil Storage Capacity	170mm
Field Capacity	70mm
Infiltration Capacity Coefficient (a)	210
Infiltration Capacity Coefficient (b)	4.7
Ground water initial depth	10mm
Ground water recharge rate	50%
Ground water base flow rate	5%
Ground water Deep seepage rate	0%

Table 3.2 Pollutant Node Parameters

		Mean (log mg/L)	Standard Deviation (lot mg/L)
Total Suspended Solids	Base Flow	1.20	0.17
	Storm Flow	2.15	0.32
Total Phosphorus	Base Flow	-0.85	0.19
	Storm Flow	-0.60	0.25
Total Nitrogen	Base Flow	0.11	0.12
	Storm Flow	0.30	0.19

3.3.3 TREATMENT NODES

Sediment and nutrient control is expected to occur through on-site treatment for each lot on the eastern side of the extension of Winterlake Street. Rainwater tanks for each lot were not modelled for simplicity. It is expected

[7] Lake Macquarie City Council – Water Cycle Management Guidelines, Revision 2, June 2013

that rainwater tanks, in combination with demand modelling per household would improve the water balance model and therefore should be considered as part of a more detailed investigation at subdivision application stage. Overflows from each rainwater tank will be piped to the infiltration trench aligned along the rear boundary, ultimately connected to the Outlet. The modelling represents a 1m wide tunnel trench, generally consistent with Council's standard drawing EGSD-407 constructed over a 200m length.

Table 3.3 Treatment Node Parameters

Parameter	200m TUNNEL TRENCH
Low-flow bypass (m^3/s)	None (0 m^3/s)
High-flow bypass (m^3/s)	None (100 m^3/s)
Extended detention depth (m)	0.15
Surface area (m^2)	260
Exfiltration rate (mm/hr)	0
Filter area (m^2)	200
Filter depth (m)	0.7
Filter median particle diameter (mm)	1
Saturated hydraulic conductivity (mm/hr)	200
Depth below underdrain pipe (% of filter depth)	0
Overflow weir width (m)	2
CSTR cells	3
k-C* values	*default*

3.3.4 RESULTS

The treatment train adopted for this investigation was as follows:
URBAN (Residential)→200m TUNNEL TRENCH→Junction→Receiving Node.

Table 3.4 MUSIC modelling analysis

	Total Suspended Solids	Total Phosphorus	Total Nitrogen	Gross Pollutants
	kg/yr	kg/yr	kg/yr	kg/yr
Source	991	1.70	13	175
Residual	85	0.48	7	0
% Reduction	91%	72%	45%	100%
Target Removal	80%	45%	45%	100%

MUSIC model results presented in Table 3.4 shows the treatment train effectiveness due to treatment devices in series. Reduction ratios fall within the target removal efficiencies as per LMCC's water quality standards. MUSIC modelling has also been considered with respect to LMCC's MUSIC-Link requirements.

3.4 EROSION AND SEDIMENTATION CONTROLS

Temporary measures adopted to control erosion during the construction phase would be maintained by the development contractor.

Construction of the proposed development would need to be sequenced in a manner that would divert 'clean' runoff from the undisturbed upslope surfaces around the development. The concept stormwater plan indicates that the existing farm dam is to be re-built to a suitable construction standard. It is recommended that this farm dam be rebuilt first, along with the network of pipes linking with the site outlet. A temporary outlet pipe discharging from the farm dam may be necessary for the period of time over which the proposed road extension is under construction. This is to reduce the risk of high-volume flows draining onto the road surface.

Higher sediment loads can be expected from the disturbed surface of the road subgrade, footways and batters of the road extension until adequate road seal has been placed and full turf has been established on the road

verge. Until this point, sediment fencing is recommended down slope of the disturbed surface to trap sediment flows on-site.

A separate Soil and Water Management Plan will be prepared when a Development Application is made for subdivision.

4.0 DISCUSSION AND RECOMMENDATIONS

The subject land is not impacted by flooding; however runoff from the subject land has been known to cause flooding in the streets below the site. Development of the subject land and implementation of the proposed stormwater management system will reduce the number of excess storm flows through the downstream street system by retarding flows from all storm events.

There are no other identified flooding impacts associated with the subject land.

This assessment demonstrates that the subject land is suitable to be rezoned for residential purposes from a stormwater and flooding impact perspective..

INSTRUCTION NUMBER: 16/155	F	----	----	----
FILE ID: 150445	E	----	----	----
SURVEYED: N/A	D	----	----	----
DESIGNED: N/A	C	----	----	----
DRAWN: MAC	B	EXPAND SITE AREA	MAC	20/20/2017
CHECKED: ----	A	FOR DISCUSSION PURPOSES	BC	19/01/2016
DATUM: AHD	NO.	DESCRIPTION	DRAWN	DATE
CONTOUR INTERVAL: 1.0m				

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PLAN:

FIGURE 5:
CONCEPT STORMWATER MANAGEMENT PLAN
40 RAYFORD STREET
WARNERS BAY

CLIENT:
WARNERS BAY HOLDINGS

10 5 0 10 20 30 40
Horizontal Scale 1:600 (A1)
1:1200 (A3)

No. OF SHEETS
1

SHEET No.
1

Plot Date: 20/12/2017 Cad File: 16_155 – Site Plan Report Figures Rev B (ID 150445)